USE OF ON-LINE RESOURCES BY TEACHERS OF SCIENCE: AN ANALYSIS OF SOCCI MARKET RESEARCH PROJECT DATA

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ABSTRACT

This study reports on the findings of the Schools On-line Curriculum Content Initiative (SOCCI) market research project conducted in 2001 concerning the use of on-line technology by science teachers. Specifically the study sought to define the patterns of usage, teaching and learning strategies, and conditions that favoured or inhibited the use of on-line technology. Qualitative data were drawn from classroom observations and interviews with nominated teachers and quantitative data derived from an on-line survey. Several key findings will be discussed. First, although science teachers tend to use on-line resources to develop their own dedicated teaching materials, the more enthusiastic teachers are spending considerable time preparing resources but may have reached a saturation point where the outcomes were not worth the effort. Lack of support and contextual factors within schools are significant impediments. Second, there is clear indication that students in science are using on-line technology mostly for research and information retrieval. Most science teachers in secondary schools seem to have easy access to computers and are tending to use them in science teaching spaces. Third, common software, especially word processors, is being used to support both teachers' professional work and student learning. Fourth, teachers' assessment of the current state of computers, their access, quantity and quality seemed to be favourable. The paper will discuss these findings and the related range of issues and conditions that support or inhibit the use of on-line facilities.

KEY WORDS

Science, on-line technology, primary, secondary.

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INTRODUCTION

The pace of technological development in schools has escalated to the point where employer and social demands for technological literacy has convinced governments of the value of investing considerable funds in computer technology. This provides the foundations for the knowledge economy but also there is a belief that technology can support new ways of learning [e.g. Backing Australia's ability statement (Anon, 2001)]. A coordinated approach to achieving this latter objective saw the development of the Schools On-line Curriculum Content Initiative (SOCCI). This collaborative program between the Commonwealth of Australia and the States and Territories managed by the Conference of Education System CEOs envisages the development of quality resources to support on-line teaching. The aspect of the project explored in this paper relates to an analysis of the current needs and experiences of teachers of science. The paper will commence with a selective review of why technology might be used in the support of learning. I then provide some background to the study in relation to international practices and then report on the findings of the situational analysis conducted using qualitative and quantitative methods.

Contemporary Science Teaching

To contextualise this analysis, it is important to consider some contemporary developments in the teaching of science. Several major reports have highlighted a crisis in the teaching of science in Australia (Australian Science Technology and Engineering Council - ASTEC, 1997; Batterham, 2000; Goodrum, Hackling, & Rennie, 2001) and elsewhere (Glenn, 2000, NSB, 1999). The picture painted by these reports is one where "disenchantment with science is reflected in the declining numbers of students who take science subjects in the post-compulsory years of schooling." (Goodrum et al p. viii).

Considerable research over the last two decades has provided greater insights into effective teaching and learning practices in science classrooms. Educational research has painted a portrait of the successful learner as active, mindful, inquiring, and self-monitoring. That image is clear enough to require an equally sharp picture of the settings that foster deep learning (Alexander & Murphy, 1998). These settings are characterised by complex situations in which students engage in inquiry-based learning that draws upon interdisciplinary knowledge and contributes to the development of critical and creative thinking.

Implementing these approaches in the science classroom has required teachers to reflect seriously on their assumptions about learning and teaching and to adopt approaches that in many situations are personally challenging. Pressure to adopt technology in teaching is not least among these concerns. Although, extensive observations and analyses of classroom practices reveal that most teachers embrace a vision of high standards and in particular endorse the use of technology, their instructional strategies fall far short of this vision. Indeed, it is claimed that 50% of teachers feel inadequately prepared to integrate computers into instruction (NSB, 1999). The effective use of technology is indeed a challenging task (Jonassen, Peck, & Wilson, 1999). Numerous technological innovations have held the promise to reform education. However as technologist Jerrod Zachiaris (cited in Cuban, 1986, p. 1) is reported to have said in 1966: "It is easier to put a man on the moon than to reform public schools."

What Use Is Technology?

Why is it important for technology to be incorporated into learning and especially into science learning? In this context, technology refers to any form of computer-mediated information retrieval, analysis or communication. As Roy Pea (2000) points out, "human beings are fundamentally and distinctively symbol-making and symbol-using animals. Fluencies with expressing and interpreting symbolic representations are at the core of what it means to understand subject matter domains, to put knowledge to use in activities" (p. xv). Computer technology has the potential to amplify and extend human thinking by inventing new forms of representation including graphics and facilitating analysis and communication of information. The non-linear forms of communication allow greater interactivity and structuring of knowledge. For example, hypertext, simulations, virtual reality and mindtools open up new forms of experience, discourse and reflection. Enhanced communication tools such as e-email, discussion forums and synchronous facilities including video conferencing generate greater possibilities for discursive practices valued in learning. Technology also provides a means of extending the sensitivity of humans to information. For example, data logging devices provide opportunities for collecting information about systems, web-cams enable remote sensing of events often beyond the experience of students and robotics introduce opportunities to extend human control of the environment.

The Use of On-line Technology In Science

Computer technology and science education have been comfortable bedfellows for almost two decades. Innovative teachers in the early 1980's were using computers to control devices and measure a range of physical properties in laboratory work. These studies demonstrated the capabilities of computers to produce dynamic, symbolic representations of abstract phenomena in ways that helped novice learners to construct rich mental models and understandings (Kozma, 1991). In the 1990's, with the advent of the Internet, the use of technology expanded considerably to provide access for children to novel and exciting learning experiences. Some of these have been documented (Jacobson, & Jacobson, 1998.) By way of illustration, several projects stand out as exemplary applications of the Internet.

One project involves providing access to schools to a computer-controlled telescope provided by the Harvard-Smithsonian Centre for Astrophysics. This access enables teachers and students to view space from the classroom (http://mo-www.harvard.edu/MicroObservatory/AboutUs/index.html). Another major project that involved many thousands of students in the US was the CoVis Project. Through the use of advanced technologies, the CoVis Project attempted to transform science learning to better resemble the authentic practice of science (Edelson, 1997). This project involved both a focus on collaborative learning and good pedagogical principles coupled with access to high quality on-line resources and software to provide authentic simulations. The Knowledge Integration Environment (KIE) Project (Shear, 1998), HI-CE at the University of Michigan (Krajcik, & Starr, 2001), Web-based Inquiry Science Environment (WISE) based at University of California Berkeley and the *Global learning and observation to benefit of the environment* (GLOBE) program were similar major Internet-based projects that encouraged collaborative on-line communication and simulation programs. In the WISE project students worked on investigative topics such as genetically modified foods, earthquake prediction, and the "deformed frogs mystery" (e.g. (Linn & Hsi, 2000).

Although integrated on-line resources have occupied a prominent role in contemporary science teaching, others continue to advocate the importance of other technological resources. Rodrigues, (1997) has reviewed the use of computer-based technologies and identified a number of important tools that should be integrated into contemporary science teaching where appropriate. These include the range of usual software such as Word Processors, Spreadsheets and presentation packages as well as simulation software, communication facilities and CD-ROM based databases. Nevertheless, the research that has addressed specifically the use of technology in science teaching has supported integrated, investigatory-based long-term projects and the like, coupled with model eliciting software (e.g. Roschelle & DiGiano, 2002).

METHODOLOGY

A full description of the methodology for the main study has been reported elsewhere (Cooper et al. 2001). In brief, the project was conducted during the middle of 2001 and employed a mixed-method design, comprising quantitative and qualitative components. The quantitative component was a survey of 100 teachers at 88 schools, while the qualitative component comprised interviews and classroom observations of a range of teachers selected because they were currently engaged in using on-line resources in their teaching. The state and territory education representatives on the SOCCI RESEARCH ADVISORY GROUP purposefully selected sites for observation based on local knowledge of good practice. Teachers from all states were interviewed and their classes observed.

1. *Teacher Survey* This was an on-line survey designed to gather self-report data from as many teachers as possible across Australia on what and why they currently use on-line curriculum materials, as well as their perceptions of what on-line resources they would prefer to use given the opportunity. The survey also investigated how teachers perceive teaching and learning with on-line curriculum

materials impact on their students' learning outcomes, as well as barriers to full adoption such as issues of access.

2. *Teacher interview*s. These were semi-structured and designed to validate and illuminate data obtained from the surveys. They focused on teachers' affects, beliefs and classroom practices and what influences their use and non-use of on-line curriculum materials and were recorded.
3. *Classroom Observation*s. These focused on both the extent and type of on-line curriculum material used in the classroom and the teachers' classroom practices with respect to this material. The researchers took field notes and also collected artifacts.

RESULTS AND FINDINGS

The quantitative findings will be reported first followed by selective qualitative data. A more detailed description of the outcomes of interviews with teachers and classroom observations has already been reported. The qualitative data described here will be analysed to support an interpretation of the survey findings.

Analysis of Quantitative Data

Fifteen respondents in the main study of 100 identified themselves as science teachers. Given a low response rate for science teachers, the analysis of the quantitative data is primarily descriptive and qualitative. The following five sections of the survey will be reported:

- *Demographics*
- *What on-line curriculum content, materials and tools do you and your students use?*
- *Why do you and your students use on-line curriculum resources in the teaching and learning context?*
- *How would you assess the Information and Communications Technology (ICT) resources that are available to you and your students to facilitate your use of on-line curriculum materials?*
- *Miscellaneous questions*

Demographics

Details of the teachers, their schools and general level of education are presented in Table 1.

Table 1
Teaching profile of respondents

Location	State	Age band of teacher	Years of experience	Gender	Highest Qualification	Grades taught
Urban	NSW	30-39 years	11-15 years	Male	Graduate Diploma	7,8,9,10
Urban	Qld*	50-59 years	20+ years	Male	Bachelors degree	8,9,10
Urban	Qld*	30-39 years	6-10 years	Male	Graduate Diploma	8,9,10
Urban	Qld*	50-59 years	20+ years	Male	Graduate Diploma	Nil response
Urban	Qld*	50-59 years	20+ years	Male	Bachelors degree	9
Rural	Qld	30-39 years	11-15 years	Male	Bachelors degree	8,9,10
Urban	SA	40-49 years	20+ years	Female	Graduate Diploma	9
Urban	SA	50-59 years	20+ years	Male	Graduate Diploma	9
Urban	SA	40-49 years	16-20 years	Female	Bachelors degree	8,9,10
Urban	SA	50-59 years	20+ years	Male	Doctorate	8,9,10
Remote	SA	60+ years	20+ years	Male	Masters degree	9,10
Urban	SA	40-49 years	20 years	Male	Bachelors degree	Nil response
Regional	VIC	40-49 years	16-20 years	Male	Graduate Diploma	Nil response
Urban	WA	40-49 years	20+ years	Male	Graduate Diploma	8,10
Urban	WA	50-59 years	20+ years	Male	Graduate Diploma	8,9,10

Notes: *Four teachers from the same private urban school

The profile indicates a highly experienced, confident cohort of mostly male senior teachers. All reported to be self-trained although one Queensland teacher was undertaking further studies in "on-line" education at Masters Level, a West Australian teacher was studying a graduate certificate and a Victorian teacher had completed a graduate diploma in computing.

In summary, this group appears to be comprised of highly competent and advanced users of technology and is experienced in teaching.

Types of Materials Used

By teachers: Teachers were asked to indicate from a list how *frequently* (Never, Sometimes, Frequently and Very Frequently) they **currently** used on-line curriculum content, materials and tools, as well as how frequently they would **prefer** to use the same list of on-line resource items.

Analysis of the ways that computers are used to support on-line delivery shows that teachers, on average, use word processing options most in order to support communication and on-line search engines (See Figures 1 and 2). When asked to rate their preferred use there was only a small shift to increased use of search engines and a small **decrease** in use of word processing. E-mail, spreadsheets and WebQuests were also used on average "sometimes" but there were indications of greater use in a preferred setting. However, the most significant changes reported in a preferred environment are the use of authoring tools and on-line simulations. The average response to all questions in this section was "sometimes" with only the use of word processing given as "frequently".

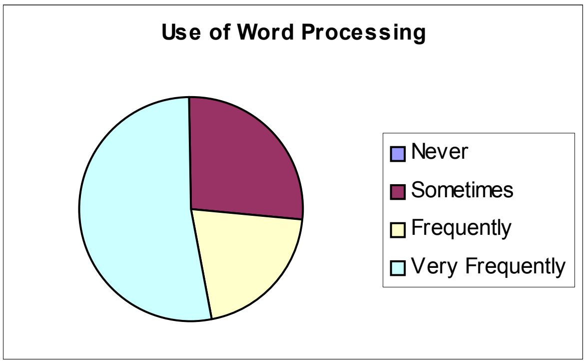

Figure 1: Use of word processing to support communication by teacher

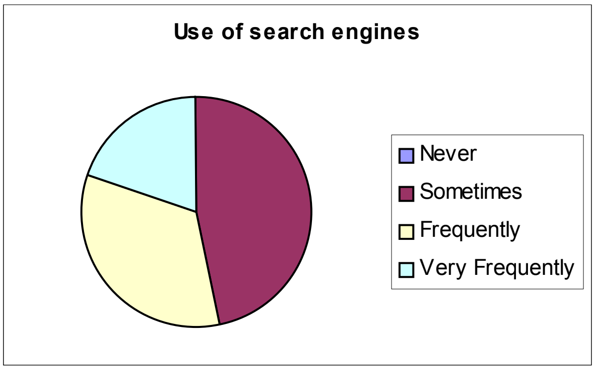

Figure 2: Use of on-line research tools such as search engines by teacher

There is a general indication that teachers would prefer their students to use more technology but the data suggest these are relatively moderate changes in expectations.

By students: A similar probe was directed at their current and preferred options for students. Teachers' descriptions and frequencies of the use of particular resources by students were thus gleaned from a series of eight questions. In broad terms, usage appeared low with science teachers' average response at the level of "sometimes." The most notable exception was in response to the question "To facilitate learning my students use a variety of search engines to conduct research on the WWW". Although some teachers stated their students did not use the Internet, most did report high usage (Figure 3). Furthermore, teachers also indicated an increase in the use of the Internet by students for research.

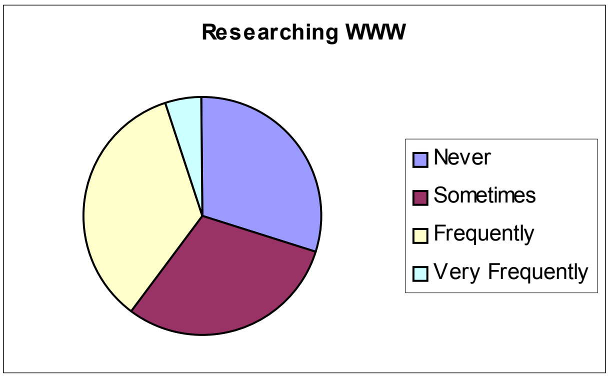

Figure 3: Extent of student use of WWW.

Reasons For The Use of On-line Resources

By teachers: When asked why teachers used on-line resources they provided responses indicating mostly "sometimes". The most common use of on-line resources by teachers was for the design, storage and sharing of instructional materials such as individual activities or whole units of work. Most other applications were used only "sometimes" on average. Those applications preferred included the use of resources to teach students remotely, to support collaboration and to encourage access to education at more flexible times, places and paces.

By students: The frequency for the use of on-line resources by students is generally low with average responses mostly below "sometimes". The most frequent use is to access on-line curriculum resources to work at their own pace or to access learning tasks from home or other sites outside the classroom. The most desirable use appeared to be for communication and web publication, and to use on-line curriculum resources to solve authentic problems. However, even in a preferred environment the level of application was relatively low.

Assessment of Technology Resources.

Teachers' assessment of the current state of computers, their access, quantity and quality seemed to be favourable. Access to the Internet was rated as "very frequent". The major concern was with number available. There was nevertheless perceived to be room for improvement in most areas.

When describing the use of peripherals there appeared to be some consistency in use. Scanners, digital cameras and data logging equipment were reported in addition to printers as the main peripherals. On average, responses indicated peripherals were readily accessible, user friendly, complementary with other hardware, reliable and supportive of learning. There was room for improvement in all aspects of the use of peripherals. Access to more data logging and specific sensor equipment for use in science was a feature of responses concerning improved peripherals.

Comments about access and use of software seemed to indicate satisfaction and frequent use. In particular, there was a perception that software could be used to extend students, and that it was user friendly. The adaptability of software to be capable of multimedia applications and to meet individual needs were seen as issues in need of attention. Teachers reported that the most common software were Microsoft Word, Excel, PowerPoint and Adobe Acrobat. In addition, specialist data logging software featured among a number of respondents' replies. Preferred additions included Corel Draw, publishing software and specialist programming languages.

Perceived levels of support in all areas of computer use were rated as "sometimes" with indications of a preferred level much higher. It would appear that support is an area that is perceived to be in need.

Open Ended Questions

This section reports data from nine open-ended questions. Responses to each are reported consecutively.

Main reason for using on-line curriculum resources

Teachers reported a range of reasons for using on-line curriculum resources. These included the provision of variety in means of delivery, efficient instruction and access to things that students would not otherwise see. Relevant, up-to-date information, and latest research featured among almost a third of respondents. They expressed opinions that software should be appropriate to the content and level being taught, it should be visually appealing, readily accessible and be engaging. Software should be learning tools, not just "lectures on computer."

To be useful to me in the classroom on-line curriculum resources must
They expected the software to be able to do things, or present information, better than textbooks or other means could do. Students should be able to navigate easily between research areas and be relevant to the contemporary syllabi. There was a perceived need for software and resources to be relevant, well presented, interactive, and be capable of fast downloading from web sites. It should be written in language easy for students. Some teachers argued that resources should take an integrated approach. They expected that on-line resources should be readily accessible, not choked with irrelevancies such as advertising, user friendly, and be specific to a theme or learning area.

Major reason I would choose other resources instead of on-line curriculum materials
When asked what the major reason would be to choose other resources instead of on-line curriculum, teachers responded identifying a range of issues. Practical experiences were highlighted. For example one teacher stated:

> when I think the process needs more teacher input, when it is more important to actually do a science experiment and observe the changes in real life with the chance of making mistakes!

Others argued that classes were too crowded to use computers or that availability was not ideal. Slow download times were also cited as reasons for not using computers.

The most useful on-line materials
Within specific teaching areas the most useful on-line materials are those that allowed simulations, interactive, enable data analysis such as tabulation and graphing and allow student input. For example:

> The Jason Project allowed students to ask and answer questions in a controlled chat room as well as posing questions that were answered by scientists currently working in the relevant area.

How is on-line teaching different?
When asked "How is on-line teaching different from other approaches to teaching?", responses included "more constructivistic", "less emotional", facilitates different learning styles and provides more control to the learner. In addition, one teacher summarised the differences in terms of flexibility:

> It allows much more flexibility in terms of time. Because it is pre-prepared the teacher has more individual contact with students. Students seem to have more time on task.

How do you integrate on-line resources?
Teachers were also asked: "How do you integrate on-line resources with your other pedagogical practices?" This produced a range of responses including reference to amount of preparation time and more practical responses. For example:

> Careful research (many hours at home) to search for appropriate websites and information that the student will understand at their current level as well as alternative sites if that information is to be shared. Students will often give a presentation of their projects.

> By embedding the use of on-line sites within worksheets to supplement class materials

Advice for a beginning teacher
When asked: "Do you have any advice for a beginning teacher who wants to use on-line curriculum materials in their classroom?" responses included a range of advice including management, relevance and simplicity:

> It has to be simple to use, it has to work the first time! There needs to be a variety available to take into account the wide variety of computing skills of teachers.

Others emphasised pedagogical principles, for example:

> They must be on CD-ROM and encourage higher-order thinking in an outcomes-focused and constructivist learning environment.

Advice for developers
Advice to developers was gleaned by asking "Is there anything that you feel developers should know when they are considering creating on-line curriculum materials for teachers to use?" Teachers' responses emphasised simplicity, good range of international contacts, flexibility and "better than a book", and "encourage higher order thinking".

Other issues
A final question probed: "Is there anything else you want to add to the information you have already provided, that you think is important for the future development of on-line curriculum resources?" Several types of response were received including advice to consult with teachers as material is developed and to ensure that material is relevant to different syllabi. There was also an expectation that materials should have "options", "be interesting" and meet the needs of students of different abilities.

Qualitative Data
The use of computer technology in teaching science was observed in ten schools - five primary and five secondary across all states. Most applications of on-line technology, which were explicitly related to science, involved the students undertaking some form of investigation. For example, in one secondary school students were researching the problem of why frog populations are declining around the world. To achieve this the teacher provided text based curriculum materials hyperlinked to websites that he had previously identified. The students worked from the science laboratory accessing material as needed. The on-line component was integrated with both practical science activities involving frog anatomy and the use of various software to support report writing and presentation. Most of the secondary schools used the on-line facilities from their science rooms in this fashion. The consensus among these teachers was that the Internet provided better and more up-to-date information than a "well-resourced" school library. In another situation, the teacher stated that it was possible to do experimental work that would have been impossible without the computer, such as using data probes to observe a graph of the cooling curve of hot water. In contrast, however, the inquiry approach was rarely used in primary classrooms with most teachers using packaged software which provided conceptual information, not only for the students but also for themselves.

However, it was also evident that the availability of technology was impacting on the nature of the secondary science classroom environment. Whether this is entirely due to the technology or consequential of other systemic developments is difficult, if not impossible to ascertain. What is speculative is that technology affords more student centred pedagogical practices.

Thus in summary, on-line technologies seem to be incorporated in investigatory activities as a tool for information retrieval. The rationale was that the quality of information available on the Internet was both appealing and extensive albeit often unrelated to local regional contexts. For some teachers it also provided insights for students into the real world of practising scientists. On-line facilities are often used in conjunction with report writing and presentation software.

The Needle in The Haystack
Access to suitable websites was a significant issue. The considerable amount of information available on the web is daunting and exciting. Whilst open-ended inquiry is desirable, these practices need considerable scaffolding otherwise students engage in "surfing the net" with little tangible outcomes in relation to the goals of a particular lesson. Hence, teachers who had been using the Internet for some time preferred to give students pre-selected sites, rather than letting them search more widely. They did this by providing annotated pages of links or by creating web quests incorporating such links, or at least by providing links to search engines and directories that they knew would help students be successful in their

searches. The need to develop intranet-based resources was also exacerbated by the existence of filters and firewalls that limited access to useful sites.

Several teachers spoke about the importance of materials being immediately relevant to the curriculum topics at different levels of schooling, and then being suitable for students (of varying ability) at that level. Furthermore, teachers argued that software needed to be appealing, easy to download and to be interactive as well as easily compatible with existing curricula and topics.

CONCLUSIONS and IMPLICATIONS

The study has revealed some insights into the practices adopted by teachers of science in using on-line technology. The study identifies as small band of highly committed and talented teachers willing to explore new ways of teaching supported by technology but there is little evidence that large numbers of teachers are using technology in ways that enable powerful learning to occur. Clearly there was an emerging pattern and awareness by some teachers that on-line technology was a tool that could enhance learning through elaboration of learning processes rather than just a repository of information. Having noted this it did appear that this awareness seems to be developed after considerable engagement with software or applications that are more content driven. Despite this there was the sense of disillusionment among those who were employing technology in supporting learning by providing access to content. This concern is shared by others (Glennan & Melmed, 2000) who advocate the development of software that "incorporates some of the structure of current textbooks" but which would be "sophisticated in pedagogy and rich in imagery" (p. 72). Such a strategy may be a pragmatic step towards education the mass of teachers not engaged in the use of technology but wanting to see value for enhancing student outcomes.

Although computers are central to authentic science, using on-line technologies as part of the school science curriculum is a complex challenge for teachers a finding consistent with the literature (e.g. Wallace, Kupperman, Krajcik, & Soloway, (2000). It is clear that quality support at both the technical and pedagogical level is essential. It is also clear that highly effective teachers are prepared to invest considerable personal time and effort. Although teachers generally seemed favourably disposed to the use of computers, a number of constraints were clearly identified most of which related to the efficiency of systems and the relevance of particular software being used.

Implications for technology in science classrooms

New communication technologies and informational technologies underpin the revolutionary advance of science and establish new discourses within the domain of science. They have generated new ways of working, new ways of perceiving and new ways of thinking. The scientific laboratory has expanded into virtual space in which scientists are constantly engaged in debate, argument and the sharing of ideas (and misinformation). The tyranny of distance has been replaced by the tyranny of timezones. The capacity of individual to monitor and understand phenomena of interest has been enhanced through automation, robotics, datalogging, computational sophistication and new ways of representing ideas (eg graphical modelling). Technical developments and the consequential development of technological practices in science have changed the discourse of science. Teachers of science will struggle with the evolving discourses given their outsider status. The prevailing perceptions of science among many teachers is the "science as information" focus. The challenge of reinventing science will require practitioners to come to grips with the emerging technological practices that pervade the field and to induct students into the discourse of this field. This raises significant challenges for teachers to be critical consumers of the technology. To what end, what assumptions, what outcomes are embedded in the use of particular technologies? In what ways does the use of the Internet, the use of CD-ROMS, the use of datalogging devices or popular robotics kits contribute to the discourse of authentic science? Technology generates information but information is secondary to understanding. Privileging information over discourse reinvents the didactic models of teaching that contemporary research on learning has discredited. Little wonder then that there exists scant evidence that using technology in the classroom increases achievement or understanding (Cuban, 1990[i];). Indeed, the seductive appeal of technology has potential to be counterproductive as implied by Kroker and Kroker (1996[ii]):

> The psychological war zone of bunkering in and dumbing down is the actual cultural context out of which emerges technological euphoria. Digital reality is perfect. It provides the bunker self with immediate, universal access to a global community without people: electronic communication without social contact, being digital without being human, going on-line without leaving the safety of the electronic bunker. The bunker self takes to the Internet like a pixel to a screen because the information superhighway is the biggest theme park in the world: more than 170 countries. And it's perfect too for dumbing down. Privileging information while exterminating meaning, surfing without engagement, digital reality provides a new virtual playing-field for tuning out and turning off.

A commitment to embedding technology into the science classroom in ways that engage learners in the discourse and culture of science are constrained but also by patterns of classroom practice that form the day-to-day reality of schools. Classrooms are complex, self-regulating communities (Lankshear, Snyder, & Green, (2000[iii])). The introduction of technology in any of its forms perturbs a system otherwise in equilibrium. Students, teachers, support staff, and the community can act to accommodate or reject the intrusion. The histories of participants, teacher knowledge and beliefs, student experiences all interact to produce a new state of equilibrium. In the process of reaching equilibrium the system is fragile and subject to collapse when any component is missing. Thus, equipment failure, absence of the teacher, or other misadventures challenge the system's confidence and capability to continue in the intended direction. While acknowledging external mishaps, internal conservativism on the part of teachers, students, parents and administrators resist change. So new technology substitutes for old technologies. Text is embedded in electronic documents instead of printed documents but little or no attempt is made to amplify educational experiences in new ways (Pea,). At best some students will experience rich and authentic experiences involving technology and technological practices in some classes but not others or at home but not at school.

Science teachers, administrators and parents share a joint responsibility to ensure that students don't just become technologically competent but that they are engaged through technology in the culture of science and furthermore have the ability to transform and actively produce technology. (pp. 30-31)

Mode	Stand alone	Web Based	
Information	CD Roms	Internet databases	
Text based	Word processes	Email, Discussion forums	
Data retrieval	Data logging	Access to remote sites	
Simulations	CD Roms/programs		
Communication		Email, Synchronous and a synchronous, Video conferencing	
Mindtools	Spread sheets, concept mapers, data bases, programming languages		

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